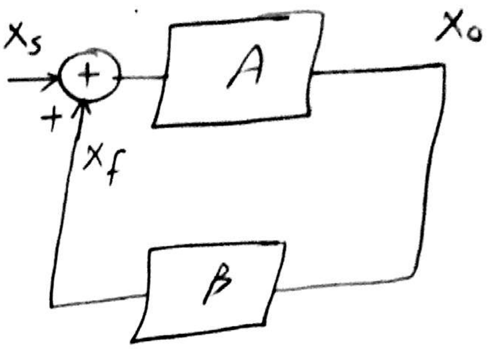
(1) In the fig. shown: the frequency selective circuit exhibits a loss of $-20\,dB$ and phase shift of $180°$. What is the min. gain & phase shift that the amplifier must introduce for oscillations to start?



Solution

$$\beta|_{dB} = -20\,dB$$

$$\beta|_{dB} = 20\log(\beta) \Rightarrow \therefore -20 = 20\log(\beta)$$

$$\therefore \beta = 0.1$$

$\Rightarrow$ For osc. to start:

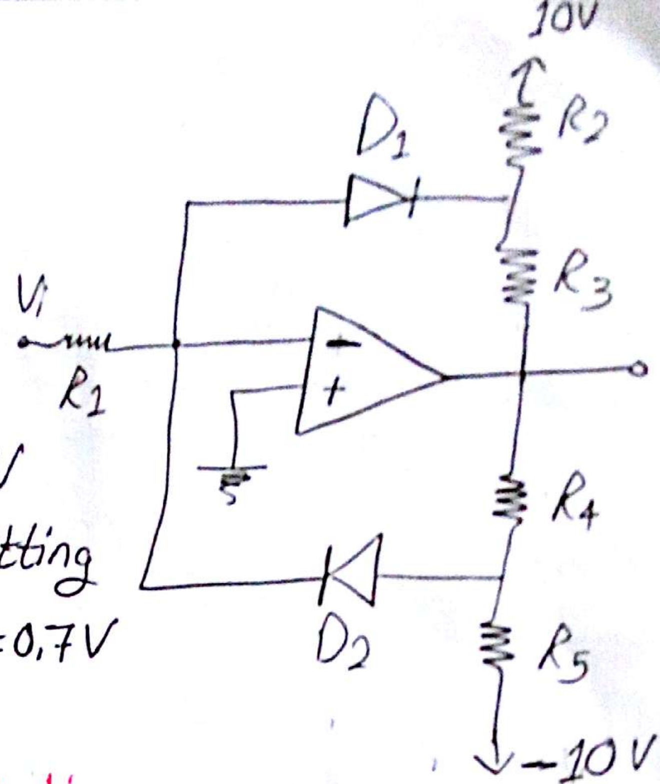
$$A\beta = 1$$

$$\therefore A(0.1) = 1$$

$$\therefore A = 10$$

(Actually: to start the osc., A must be greater than 10).

(2) For the comparator circuit shown, Find suitable values for all resistors, so that the comparator levels are $\pm 6V$ and the slope of the limitting ch/s is -0.1. Use $V_D = 0.7V$



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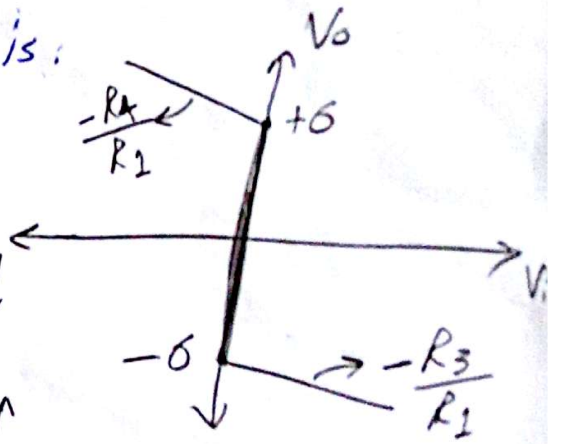
Solution

⇒ The response of the comparator is:



Slope of the limitting region in general is:

$$-\frac{R_3 // R_f}{R_1} \quad \text{for } V_o \downarrow$$

$$-\frac{R_4 // R_f}{R_1} \quad \text{for } V_o \uparrow$$

But $R_f = \infty$

$$\therefore \text{Slope} = -\frac{R_3}{R_1} = -\frac{R_4}{R_1} = 0.1 \rightarrow (1)$$

$$\therefore R_3 = R_4 = 0.1\, R_1$$

$$\Rightarrow L_+ = V\left(\frac{R_4}{R_5}\right) + V_D\left(1 + \frac{R_4}{R_5}\right)$$

$$\therefore 6 = 10\left(\frac{R_4}{R_5}\right) + 0.7\left(1 + \frac{R_4}{R_5}\right)$$

$$\therefore \frac{R_4}{R_5} = 0.4953 \rightarrow (2)$$

$$\Rightarrow L_- = -V\left(\frac{R_3}{R_2}\right) - V_D\left(1 + \frac{R_3}{R_2}\right)$$

$$\therefore -6 = -10 * \frac{R_3}{R_2} - 0.7\left(1 + \frac{R_3}{R_2}\right)$$

$$\therefore \frac{R_3}{R_2} = 0.4953 \rightarrow (3)$$

$\Rightarrow$ From (2) & (3):

$$\frac{R_3}{R_2} = \frac{R_4}{R_5} = 0.4953$$

But from (1): $R_3 = R_4 = 0.1 R_1$ ✓

$$\therefore R_2 = R_5 = \frac{0.1}{0.4953} R_1$$ ✓

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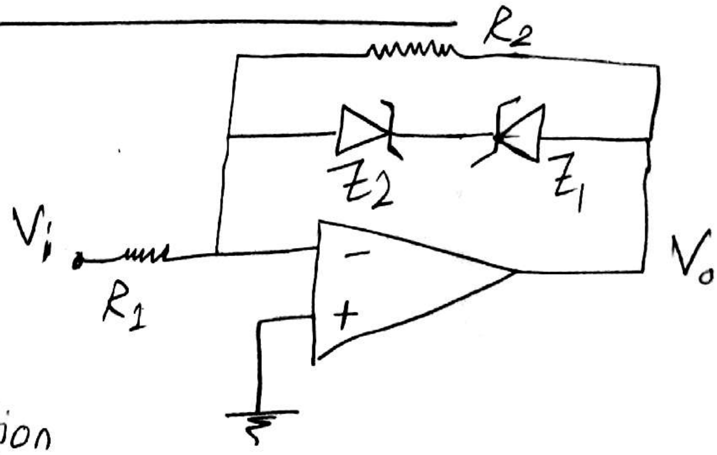
(3) a) Sketch V_o-V_i Characteristic Curve



Solution

$\Rightarrow$ When $V_i \downarrow \Rightarrow V_o \downarrow$

$\therefore$ Z_1 & Z_2 are off

$$\therefore \frac{V_o}{V_i} = -\frac{R_2}{R_1}$$

$\Rightarrow$ As $V_i \uparrow (+ve) \Rightarrow V_o \downarrow$ (more negative)

As V_o continues to decrease until it reaches the level $-(V_{Z_1} + V_{D_2})$

$\therefore$ Z_1 & Z_2 are on

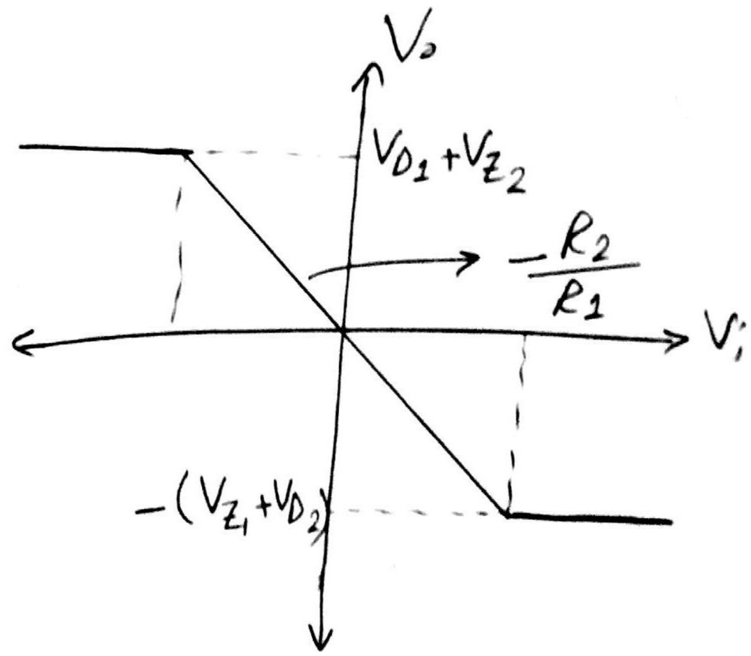
$\therefore V_o = -(V_{Z_1} + V_{D_2})$

$\Rightarrow$ $V_i \downarrow$ (more negative) $\Rightarrow V_o \uparrow (+ve)$

V_o continues to increase till it reaches $(V_{D_1} + V_{Z_2})$

$\therefore V_o = V_{D_1} + V_{Z_2}$

$\therefore$ The Ch/s:



Repeated & Solved.

(4) The three circuits of limitting circuits that were demonstrated previously.

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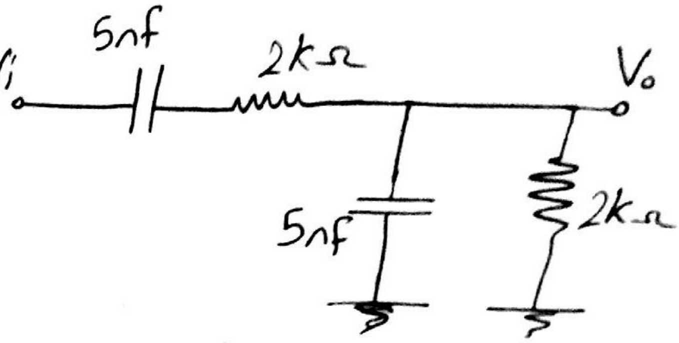
(5) Given the circuit shown.

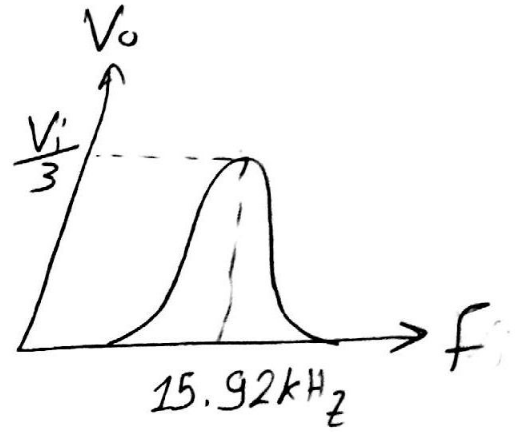


Draw the lead-lag response

Solution

$$f_r = \frac{1}{2\pi RC} = 15.92\,kH_z$$

إثباتها في المحاضرة



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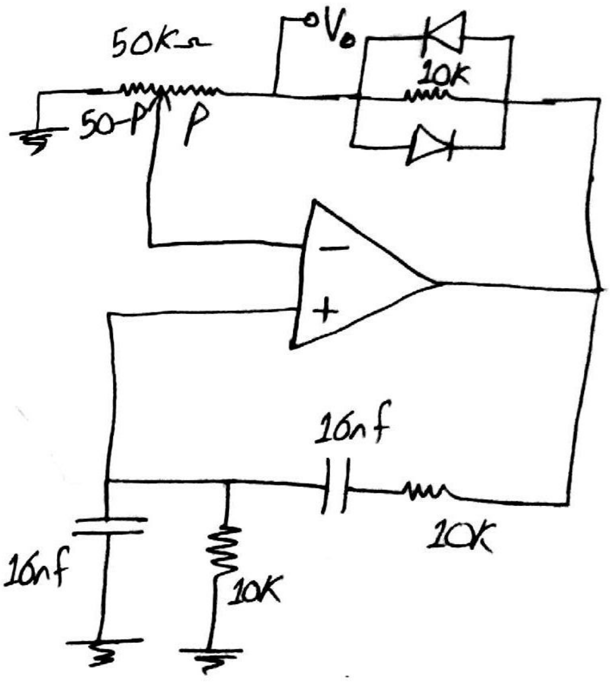
(6) a) Find the setting of potentiometer P at which osc. starts.

b) Find Osc. frequency.



Solution

a) For osc. ; $A\beta = 1$

$\because \beta = \frac{1}{3} \Rightarrow \therefore A = 3$

$$A = 1 + \frac{R_2 + R_P}{R_1} = 1 + \frac{10 + R_P}{50 - R_P}$$

$$\therefore 3 = 1 + \frac{10 + R_P}{50 - R_P}$$

$$\therefore R_P = 30k\Omega$$

b) $f_r = \frac{1}{2\pi RC} = 994.7\ H_z$

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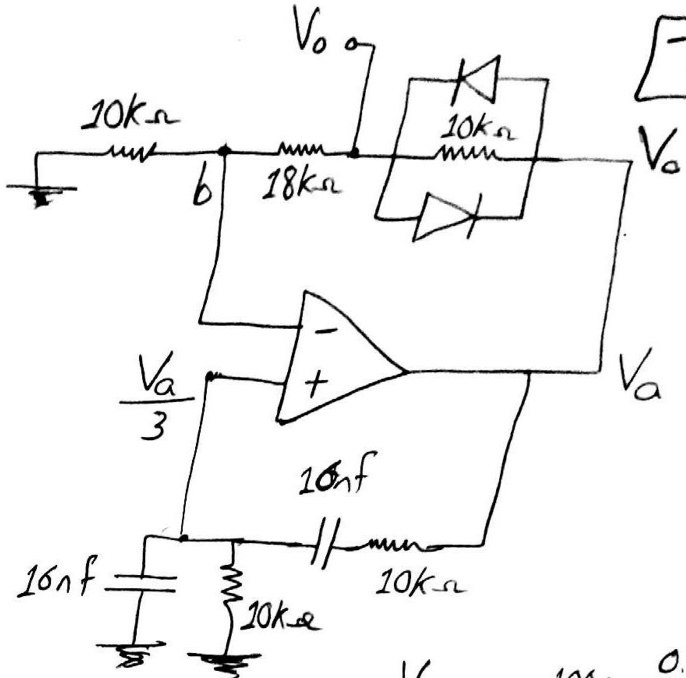
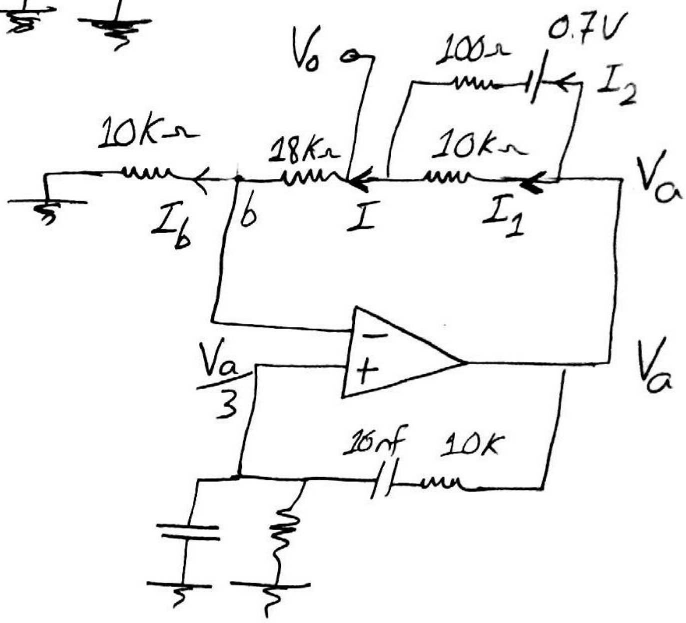
(7) $V_D = 0.7$, $R_d = 100\,\Omega$

Find $V_{o_{p\text{-}p}}$



Solution

* Consider the +ve cycle of V_o.



$I = I_b$

$\therefore \dfrac{V_o - V_b}{18} = \dfrac{V_b}{10}$

$\therefore \dfrac{1}{18} V_o = \left(\dfrac{1}{18} + \dfrac{1}{10}\right) V_b$

$\therefore V_o = 2.8\, V_b$

But $V_b = \dfrac{V_a}{3}$

$\therefore V_o = \dfrac{2.8}{3} V_a$

$\therefore V_o = 0.933\, V_a \rightarrow$ 1

$\Rightarrow I = I_1 + I_2$

$\therefore \dfrac{V_b}{10k} = \dfrac{V_a - V_o}{10k} + \dfrac{V_a - 0.7 - V_o}{0.1k}$

$\dfrac{V_b}{10*10^3} = \dfrac{V_a}{10*10^3} - \dfrac{V_o}{10*10^3} + \dfrac{V_a}{100} - \dfrac{0.7}{100} - \dfrac{V_o}{100}$

$\therefore (10.1 * 10^{-3}) V_a - 9.9 * 10^{-3} \underbrace{V_o}_{0.933 * V_a} - 7 * 10^{-3} = 0.1 * 10^{-3} \underbrace{V_b}_{\frac{V_a}{3}}$

$\therefore V_a = 8.43\,V \Rightarrow V_o = 7.87\,V \Rightarrow \therefore V_{op\text{-}p} = 15.74V$

(8) For the circuits shown:

a) Check that oscillations start.

b) Find the frequency of oscillation.

c) Find the amplitude of the output sinusoid.

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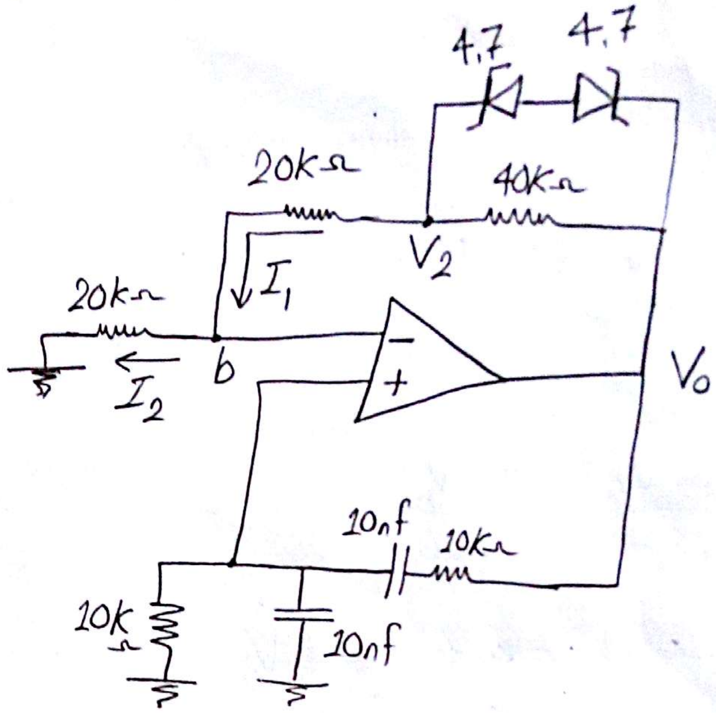


① a) $\beta = \frac{1}{3}$

$A = 1 + \frac{R_f}{R_1} = 1 + \frac{40+20}{20}$

$\therefore A = 4$

$\therefore A\beta > 1$

$\therefore$ Oscillations will start.

b) $f_r = \frac{1}{2\pi RC} = \frac{1}{2\pi * 10*10^3 * 10 * 10^{-9}}$

$\therefore f_r = 1.591\ kHz$

c) Consider the +ve cycle of V_o:

$V_2 = V_o - (4.7 + 0.7) = V_o - 5.4 \rightarrow$ ①

$I_1 = I_2$

$\therefore \frac{V_2 - V_b}{20*10^3} = \frac{V_b}{20*10^3} \Rightarrow \frac{V_2}{\cancel{20*10^3}} = \frac{V_b}{\cancel{10*10^3}} \Rightarrow \therefore V_2 = 2V_b$

But $V_b = \frac{V_o}{3}$

$\therefore V_2 = \frac{2}{3} V_o$

From ①:

$V_o - 5.4 = \frac{2}{3} V_o$

$\therefore V_o = 16.2\ V$

③ a) $\beta = \frac{-1}{29}$

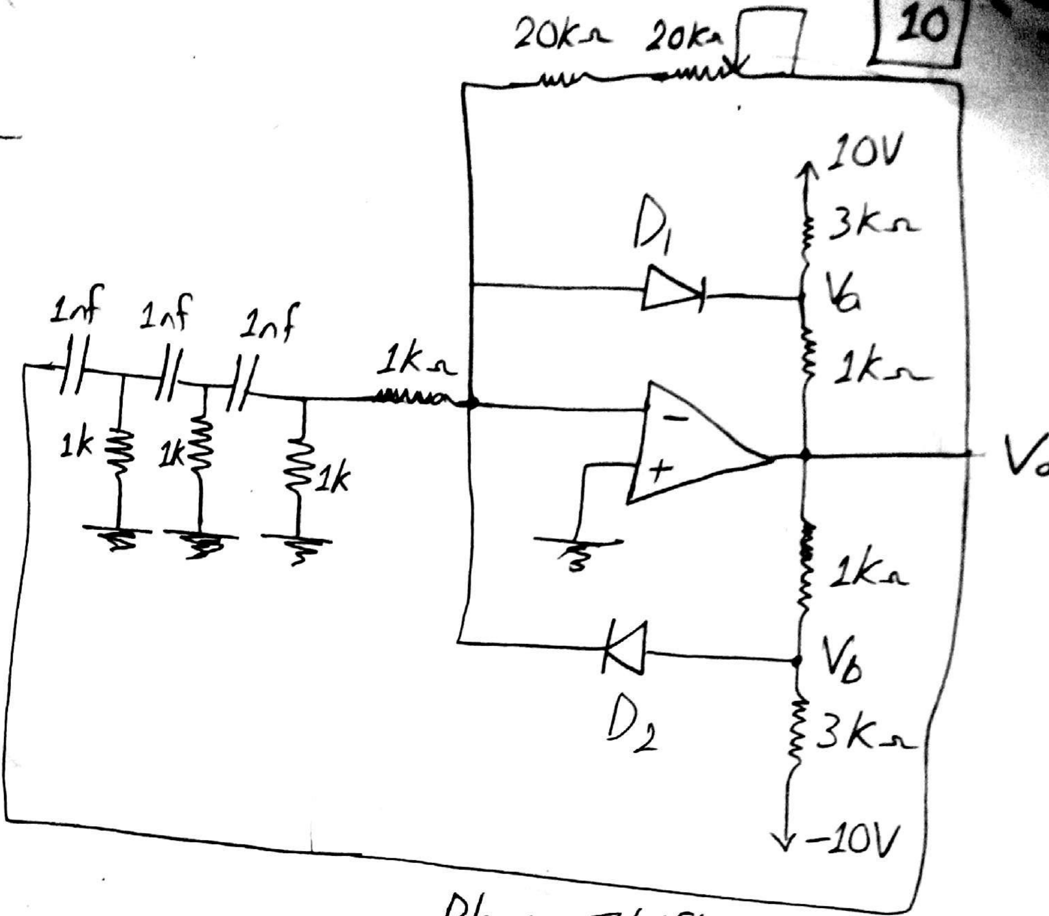
$A = \frac{-R_f}{R_1}$

$\therefore A = -\frac{20+20}{1}$

$A = -40$

$\therefore A\beta > 1$

$\therefore$ Oscillations Start



Phase Shift Oscillator

b) $f_r = \frac{1}{2\pi\sqrt{6}RC} = 64.97\,kHz$

c) Consider +ve cycle of V_o:

$D_2 \rightarrow ON \rightarrow 0.7V$

$V_b = -V \frac{1k}{1k+3k} + V_o \cdot \frac{3k}{3k+1k}$

But $V_b = 0.7V \longrightarrow$ في الشرح بناخده

$\therefore 0.7 = -10 * \frac{1}{4} + V_o * \frac{3}{4}$

$\therefore V_o = 4.27\,V$

$\therefore V_{o_{p-p}} = 8.59\,V$